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Information Technology Investments,
Top Management Compensation, and
Stock Ownership: An Empirical Study

Lawrence Loh and N. Venkatraman

June 1990

WP # 3175-90-BPS

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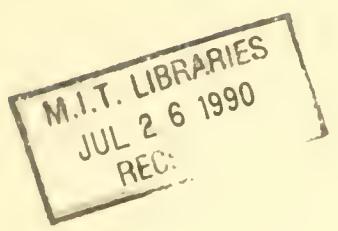


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INFORMATION TECHNOLOGY INVESTMENTS,

TOP MANAGEMENT COMPENSATION,

AND

STOCK OWNERSHIP:

AN EMPIRICAL STUDY

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April 15, 1990

Revised June 20, 1990

Acknowledgements: We would like to thank the Management in the 1990s Research Program, MIT for financial support. We are grateful to Erik Brynjolfsson for comments on an earlier draft and to Philip Johnson for assisting in the data collection. Initial discussions with Robert Goldberg crystallized some of the ideas underlying the paper.

INFORMATION TECHNOLOGY INVESTMENTS, TOP MANAGEMENT COMPENSATION, AND
STOCK OWNERSHIP: AN EMPIRICAL STUDY

ABSTRACT

A better understanding of the determinants of variations in firms' investments in information technology (IT) is important for both researchers and practitioners in the information systems (IS) function. In this study, we examined the effects of top management compensation design and managerial stock ownership on IT investments using an agent theoretic framework. We first define the 'industry-referent' IT investment as the level of IS budget necessary for firms to compete effectively in a particular industry. Initial evidence supported our premise that the absolute deviation of the IS budget from the industry characteristic level is negatively related to firm performance. Based on a sample of 72 leading US companies, we found strong empirical support for the proposition that the absolute deviation of the IS budget from the industry characteristic level decreases as: (a) the proportion of common stock held by the top management increases, and (b) the longer term emphasis of the top management compensation package increases. Implications for future research from both conceptual and methodological perspectives are noted.

Keywords: Agency theory, information systems budget, information technology investments, managerial stock ownership, top management compensation.

BACKGROUND

Information technology (IT) is increasingly viewed as an essential component of business strategy (McFarlan, 1984; Rockart and Scott Morton, 1984; Venkatraman, 1989). Consequently, there has been calls for increased alignment between IT strategies and business strategies (King, 1978; Boynton and Zmud, 1987; Henderson and Venkatraman, 1989) to ensure that appropriate resources are allocated towards developing the required IT capabilities.

Although research studies linking productivity improvements attributable to IT investments have reported weak, and negative results (Loveman, 1988; Jonscher, 1988), the level of IT investment is an important strategic choice variable of corporations with limited success in explaining corporate performance (Bender, 1986; Harris and Katz, 1990; Weill and Olson, 1989). Nevertheless the logic underlying the levels of IT investment has not received much research attention, despite the enormity of IT expenditure in firms (PIMS Program, 1984; Strassmann, 1985).

Emanating from the seminal contribution of Nolan (1973), IT investment as exemplified by the data processing (DP) budget size has been related to the stages of computing evolution in organizations (see also Nolan, 1979; Gibson and Nolan, 1974). However, the received empirical evidences do not seem to support the stage hypothesis (Lucas and Sutton, 1977; Drury, 1983; Benbasat et al, 1984). In fact the methodological and conceptual foundations underlying Nolan's hypothesis are beset with much controversies (King and Kraemer, 1984). Based on the assumption that IT expenditure changes can be a sufficient surrogate reflecting variations in an extensive spectrum of environmental, technical, organizational and

managerial factors, this S-shaped conception of DP growth does not go beyond the mere specification of intertemporal budget behavior. Indeed, the underlying important determinants of IT investments do not play a crucial role in the framework.

Researchers have usually used firm size to explain the magnitude of IT investment (Whisler, 1970; DeLone, 1981). Most findings seem to indicate that large firms tend to have more IT expenditure as a proportion of the total corporate revenue, possibly reflecting the proportion attributable to administrative systems required for effectively managing the organizational complexity.

The relationship between levels of IT investment and firm performance may also depend on the industry in which the firm operates (Weill and Olson, 1989). This suggests that there may be certain referent level of IT investment for firms to compete effectively within the structural constraints imposed by the particular industry. In fact, the notion of industry-referent level is consistent with concepts of institutional isomorphism and collective rationality, where firms competing within structural similarities of the same industry, may tend to converge in their behavioral decisions (Hannan and Freeman, 1977; DiMaggio and Powell, 1983) such as the level of investments in key strategic dimensions like IT investment.

This study is an attempt to address the relevance of critical organizational variables in determining corporate IT investment levels. It adopts an agent-theoretic framework (Ross, 1973; Jensen and Meckling, 1976) to elucidate this important choice of a value-maximizing firm. Accordingly, with the separation of firm ownership and control in the shareholder-

management relationship, the top executives of a publicly held corporation are deemed to possess a certain range of discretion or latitude of action such as key investment decisions, including the level of investment in IT.

At the heart of the principal-agent framework is the incentive payment scheme as represented by the top management compensation system (Tosi and Gomez-Mejia, 1989). Indeed, the establishment of an effective compensation strategy consistent with the organization setting and its external environment is an integral part of the strategic management process (Balkin and Gomez-Mejia, 1987, 1990; Finkelstein and Hambrick, 1988, 1989). Traditionally, the consequences of a top management compensation system has been of vital concern in explaining critical concerns such as firm performance (eg Coughlan and Schmidt, 1985; Murphy, 1985; Abowd, 1990). In addition, managerial stock ownership has been linked to corporate performance (Hill and Snell, 1989).

Within this general stream of research, this paper examines the relationship among IT investment decision, top management compensation system and stock ownership. Specifically we argue that the tendency to set a corporate IT investment away from the industry-referent level: (a) decreases with the proportion of common share owned by the top management; (b) decreases with the long term emphasis of the compensation package; and (c) increases with the short term emphasis of the compensation package. We test these propositions on a sample of the top five executive officers in 72 leading U.S. firms.

RESEARCH MODEL

The Principal-Agent Paradigm

We use agency theory as a conceptual foundation to explain the IT

investment decision process. At the core of this framework is the classical delegation of managerial task from the shareholders (i.e. the principals) to the top management (i.e. the agent) (Berle and Means, 1932).

The fundamental problem of an agency relationship is the nonalignment of goals between the two parties constituting the relationship. The agent having the locus of control will simply make decision maximizing his or her own welfare, a process which may not necessarily coincide with the optimization of the principal's utility (Ross, 1973; Jensen and Meckling, 1976). To ensure goal congruence, the principal can engage in costly albeit imperfect monitoring. Mitigating mechanisms and bonding schemes can also alleviate the agency problem.

Beside its theoretical success in economics, agency theory has hitherto been fruitfully applied to organization and strategy researches (see Eisenhardt, 1989 for an excellent review). It has for example been successful in casting new empirical insights on such firm processes as corporate restructuring (Amihud and Lev, 1981; Walking and Long, 1984; Argawal and Mandelker, 1987), takeover defenses (Kosnik, 1987; Singh and Harianto, 1989), compensation contracting (Eisenhardt, 1985, 1988; Conlon and Parks, 1988) and marketing distribution mode (Anderson, 1985). Our study adopts agency theory considerations in explaining the variations in the level of IT investment with the possible aim of encouraging considerations of the principal-agent analytical framework for other areas of IT research.

Compensation Design and Stock Ownership

The crux of the principal-agent relationship is to determine a payment structure which can optimally trades off the benefits of risk sharing with

the costs of providing incentive to the agent (Shavell, 1979; Nalbantian, 1987). In our context, the wage contract must thus be designed in such a way that it encourages full effort yet concomitantly allocates risk between the shareholders as a collectivity and the top management in the most efficient way.

Theoretically incentive contracts in a principal-agent relationship have been categorized on a spectrum based on whether they are behavior-based or outcome-based (Ouchi, 1979; Eisenhardt, 1989). In this tradition, top management compensation can be classified as base pay or contingent pay. However, due to the peculiar corporate reporting mechanism in executive compensation, it is often impossible to delineate the base component from the contingent component. Based on traditional taxonomic studies of executive compensation (Lewellen, 1968; Ellig, 1982), we decompose the pay into three parts, namely current, deferred, and stock value related. The current pay includes the annual salary and short run bonuses. The deferred pay encompasses saving plan contributions, pension payments and long run bonuses. The stock value related pay comprises stock options, stock appreciation rights, stock awards, employee stock ownership plans (ESOP) and convertible debentures. Short term emphasis of the compensation is represented by the extent in which current pay constitutes a portion of the total compensation. Long term emphasis is reflected by the extent in which deferred and stock value related pays constitute a portion of the total compensation.

Beside the actual compensation contract between the top management and the firm, another commonly used related agent-theoretic determinant of the relationship is the proportion of the corporation owned by the top

management (Hill and Snell, 1989; Singh and Harianto, 1989). Conceptually, a larger ownership ties the fate of the firm more closely to that of the management leading to a higher degree of goal alignment (Jensen and Meckling, 1976).

Determinants of IT Investments

In this study, we define IT investment to include management information systems (including both hardware and software), and related personnel, consulting and outside services expenditure as embodied within the corporate IS budget (Strassman, 1985). Broader conceptualization of IT exists to encompasses the myriad communications facilities such as telephones, facsimile, reproduction machines and so on (Panko, 1982; Weill and Olson, 1989). Although this has its merits, the proper IT domain can be ambiguous as the usage of information is embodied in almost every business processes and it is quite impossible to draw the distinction between the IT component from the non-IT component. More importantly, the definition must be conceptually sound and yet be meaningful enough to lend itself to empirical operationalization.

Past studies have used the actual level of IT investment as a basis for analysis. In an agency context, the consideration of this magnitude per se is not meaningful as both downside and upside departures of IT investment from some ideal level may be manifestations of agency problems. The focus of our research is thus on this absolute deviation of IT investment from some referent level in a particular industry. This referent level is the intensity of IT investment necessary in a certain industry in order that the firm can compete effectively vis-a-vis the structural nature of that industry. In fact, there have been suggestions that firm

performance in an industry is contingent on the level of IT investment (Weill and Olson, 1989; Harris and Katz, 1990). From a macro-organizational perspective, the level of IT investment may be influenced by competitive and institutional isomorphism (Hannan and Freeman, 1977; DiMaggio and Powell, 1983). At the competitive level, a referent intensity of IT investment can be the outcome of a environmental process that selects out certain viable organizational configuration such as in the level of IT investment. At the institutional level, the tendency for firms to converge in IT investment decisions may be a response to the three mechanisms of isomorphic change highlighted by DiMaggio and Powell (1983). Firstly, the need for legitimacy especially vis-a-vis the shareholders may exert coercive pressures for firms in an industry to emulate those perceived to be successful. Secondly, the industry-referent IT investment level may be a mimetic outcome arising from environmental uncertainty especially when the underlying organizational technology is poorly understood. Thirdly, the growing professionalization of IT managers in areas such as the homogeneity of formal education or the creation of professional networks may tend to establish certain norms for IT investment within an industry.

Our study is based on the premise that a greater deviation IT investment from the industry-referent level will give rise to a lower firm performance, which will be reflected as a lower expected firm value in an informationally efficient stock market (Ball and Brown, 1968; Fama, 1970). This initial conjecture which forms the basis of our framework will be verified empirically later.

Assumptions

Before we develop the agent-theoretic foundations of the IT investment

model, we need to highlight three assumptions. *Firstly*, we use only a partial equilibrium framework. In particular, we assume that managerial stock ownership and/or long term pay emphasis imply lower agency costs, and short term pay emphasis implies higher agency costs. *Secondly*, the expected rate of decrease of firm value with respect to the deviation of IT investment from the industry-referent level can be mitigated by the executive stock ownership or the long term emphasis of the compensation package. This supposition is reasonable as a manager whose payoff is dependent on deferred or stock value related pays will have better incentives to alleviate the magnitude of the firm value-IT investment deviation transformation. *Thirdly*, the expected rate of decrease of firm value with respect to the deviation of IT investment from the industry-referent level can be exaggerated by the short term emphasis of the compensation package.

Hypotheses

Three hypotheses underly our theoretical perspectives, as discussed below.

Hypothesis 1: There is a negative relationship between the proportion of outstanding common shares held by the top management and the deviation of the IT investment from the industry-referent level. ■

Intuitively, this hypothesis indicates that having a top management with a larger stake in the uncertain performance (or value) of the firm mitigates the agency costs inherent in its relationship with the shareholders. The disciplinary effect of stock ownership thus tends to produce IT investment in line with the industry-referent level. This hypothesis is based also on our earlier discussion on isomorphism, where shareholders can collectively, as a constituency, influence the managers in

setting isomorphic IT investment level.

The tendency to shirk or to engage in excessive perk consumption when the agent's welfare is independent of the outcome, is a well established result of agency theory (Jensen and Meckling, 1976; Rees, 1985). Nevertheless, the mathematical verifications are very generalized and complex. We offer below a simplified comparative statics treatment that is particularly tailored to our setting.

We use a moral hazard interpretation of corporate IT investment. Let us represent the utility function of the risk averse manager¹ in its certainty equivalent² form $U(a,s)$ where a is the deviation of IT investment from the industry-referent level and s is the share of the firm owned by the manager. The argument a can be interpreted as excessive perk consumption in IT where executives derive joy from having ultra modern offices loaded with unnecessarily high powered computers and other technological gadgets. On the other hand, it may represent an extremely conservative behavior of status quo where the executives for reasons such as the lack of effort in acquiring information, simply do not keep up with technological changes in the industry.

Let $V(\cdot)$ be the firm value, $c(\cdot)$ be the cost or disutility of budget

¹The cause of this managerial risk attitude is by virtue of the employment where the bulk of the executive's investment portfolio in the form of human capital is invested in the corporation. To the extent that his skills are specific to the firm and the market for executive labor is imperfect, there is a lock-in effect. The end result is executive risk aversion (Shavell, 1979; Marcus, 1982).

²The certainty equivalent form is a more convenient way to work through utility problems for it subsumes risk aversion. To be precise, $U = u^{-1} \circ E u$ where U is merely the composite function of the inverse of the usual von-Neumann Morgenstern utility function u and the expected utility function (E is the expectation operator). The problem is thus isomorphic to using $E u$ as the functional form.

deviation to the manager and k be some fixed salary. The sources of this disutility to the risk averse manager due to higher uncertainty and variability associated with a greater IT investment deviation. The function c is increasing and convex as in a typical economic cost function. Writing the utility function of the manager in its quasi-linear form, the manager simply solves

$$\underset{0 \leq a \leq a}{\text{Max}} \quad U(a, s) = sV(a) - c(a) + k$$

Here we assume that there is an upper bound a on the budget deviation adopted by the firm. This is analogous to a resource constraint as it will be unrealistic to assume that a firm can invest infinitely. In addition, the actual budget must be non-negative. By our earlier assumption, the first derivative V' is negative. If the problem has a corner solution, the optimal level, a^* is simply zero, that is set a budget equal to the industry-referent level. In the more interesting case of an interior solution, the first-order necessary condition to the optimization is

$$sV' - c' = 0$$

Total differentiation of this equation gives

$$V' ds + s dV' = c'' da^*$$

This implies that

$$\frac{da^*}{ds} = -\frac{1}{c''} (V' + s \frac{dV'}{ds})$$

Now we know c'' is positive. By our earlier assumptions, V' and dV'/ds are both negative. Thus da^*/ds is negative, which forms the underlying rationale for Hypothesis 1.

Hypothesis 2: There is a negative relationship between the long term emphasis in the top management compensation package and the deviation of the IT investment from the industry-referent level. ■

This hypothesis seeks to highlight that incorporating a longer decision making horizon into a manager's wage structure encourages goal alignment with the forward looking shareholders. This is also analogous to tying the payment of the top management to the actual long run performance and survival of the firm.

To verify, we introduce another argument into the function V . Thus we have $V(a, m)$ where m represents the long term emphasis. Solving the problem, the first-order necessary condition with respect to a is³

$$s V_a - c' = 0$$

Total differentiation of this condition gives

$$V_a ds + s dV_a = c'' da^*$$

This implies

$$V_a \frac{ds}{dm} + s V_{am} = (c'' - s V_{aa}) \frac{da^*}{dm}$$

At a particular s , we then have

$$\frac{da^*}{dm} = \frac{s V_{am}}{(c'' - s V_{aa})}$$

Now V_{aa} is non-positive applying the law of diminishing returns in economic theory. Furthermore from our initial argument, V_{am} is taken to be negative. The overall result is that da^*/dm is negative.

³ Subscripts in the variable V denotes partial differentiation with respect to the relevant variable.

Hypothesis 3: There is a positive relationship between the short term emphasis in the top management compensation package and the deviation of the IT investment from the industry-referent level. ■

When the pay contract of the top management stresses decisional myopism, the degree of goal incongruence with the shareholders will be higher. Thus there is a greater tendency for managers to shift away from the industry-referent level. Its verification can in fact be easily extended from that of the previous hypothesis. Essentially, this requires us to demonstrate that the change of a^* with respect to short term emphasis is positive based on our earlier assumptions.

METHODS

Sample

The list of publicly held corporations taken from the Premier 100 companies from *Computerworld* (September 11, 1989) constitutes our sample frame. These firms are ranked based on their IS effectiveness in 1988 using criteria such as the strength of IT plan, the currency of IS, the level of employee training and the IT accessibility. A major reason for our reliance on this source is because it contains data on IT investment level for the firm. The actual sample for the study covers those 72 companies spread over a total of 13 industries for which complete compensation data are available for the five highest paid executive officers.⁴ Appendix A provides a listing of the firms included in our sample.

IT Investment

Data pertaining to the level of IT investment are obtained from the

⁴Out of the 100 possible companies, we manage to obtain 78 updated proxy statements pertaining to the year 1988. Of these, 6 companies do not give sufficient information for us to compute all the individual categories of the executive compensation package.

abovementioned issue of *Computerworld*. The dependent variable used is based on the IS budget as a percentage of revenue, which has been used frequently in prior research (see Weill and Olson, 1989). To adjust for inter-industry differences, the IS budget is standardized by subtracting from it the industry-referent level and dividing it by the corresponding industry standard deviation. The absolute value of the resultant deviation is used for the analysis.

The industry-referent IS budget is computed as the mean IS budget of the top ten IT effective companies in that particular industry. This is justifiable as these top ranking firms are in fact the most competent in terms of their IT capability and sophistication, and arguably this may be due to its ability to set proficient IT investment level.

Top Management Compensation

Compensation data pertaining to top executives of the firm are acquired from the proxy statements filed by the respective companies for the year ending 1988. The individual components are categorized into (1) current pay, (2) deferred pay, and (3) stock value related pay. All compensation figures are computed on an annual equivalent basis, that is, they represent what the executives have attained for each of the specific item in the year 1988. As far as possible, the accrual basis of accounting is used. This is superior to taking only realized items during the year.

Current pay comprises the fixed salary and short run bonuses. It is necessary to add these figures together as they are reported as lump sums in most of the proxy statements. Deferred pay is calculated as the total of the savings plan contribution, the long run bonuses and the pension annuity. The computations of savings plan contribution and long run bonuses

are straightforward but that of pension annuity requires some elaboration. In most companies, there is a fixed schedule of pension entitlement upon retirement based on the number of years served. Using these information, we compute the annual equivalent pension annuity from each executive's present age to the retirement age using the pension entitlements from the retirement age to the mortality age.⁵

The computation of stock value related pay is not straightforward. From a taxonomic analysis of the various executive compensation packages, there seem to be a wide array of items such as stock options, stock appreciation rights, stock awards (direct, restricted, performance-based, or deferred etc), stock purchase plans, employee stock ownership plans (ESOP) and convertible debentures.

The main challenge seems to be the assignment of an appropriate value for the executive stock options. Here, the major empirical problem is that these very special securities are not traded in the financial markets. Thus their fair market values cannot be derived from observable transaction outcomes. In fact, there is considerable debate as to the correct valuation approach (Ellig, 1982). Many models of value estimation exist, ranging from

⁵ Accordingly, we obtain the age of the relevant executives from CD Corporate, one of the several CD-ROMs in the One Source line of information from Lotus Corporation. The expected life spans of human beings are then acquired from the *Life Tables for the United States: 1900-2050*, an actuarial study compiled by Joseph Faber. For male persons, the average life span is 73 while that of female persons is 80. The retirement age in the United States is taken to be 55. The discount rate used is that of the Treasury bill in 1988, which is 6.7 per cent (*Value Line*, 12/22/89). Naturally, these computations are only approximate as executives may not retire at the age of 55 or may not be entitled to any pensions in some cases if they happen to get fired. Furthermore, the mortality age is only a rough figure fraught with uncertainty. The riskless interest rate may not be the appropriate discount rate for the investment portfolios of different executives.

prospective models using a forecast of stock prices to retrospective models using the hypothetical difference between stock price and exercise price. Complex mathematical valuation methods of executive options based on the *ex ante* models of Black and Scholes (1973) have been used (Antle and Smith, 1985; Murthy, 1985). Although theoretically most defensible, the Black-Scholes option valuation model or a specialized executive option model of Noreen and Wolfson (1981) cannot be used for all options in all years.⁶ In our study, we use the difference between the average stock price and the average exercise price as the value of the option⁷. This is necessary as many of the companies do not provide the full range of data needed for the theoretical valuation. More importantly, our method is internally consistent and is definitely superior to a simplistic usage of the value realized by individual executive. In addition, it is in line with computational suggestions laid out by Lewellen (1968) and Ellig (1982). The total value of the stock options accruing to an executive is the number of option granted multiplied by the value per option.⁸

For the valuation of the stock appreciation rights, we use the same principles as those pertaining to stock options. We take the difference of the average stock price and the average exercise price and multiply it with

⁶ In the first place, these formulas are misspecified for options that are deep in-the-money. In fact, as mentioned in the study of Antle and Smith (1985), there are some instances in the sample which give estimates below the spread between the current stock price and the exercise price. For these cases, the spreads are simply taken to be the value of the respective options.

⁷ The average stock price is estimated by taking the mean of the highest and the lowest stock prices for the year 1988. These figures are taken from the Moody's Manual for the respective industrial sectors.

⁸ As the value of any option is non-negative, in a few instances where the computed figures are negative, we assign values of zero to the options.

the number of rights granted. As for the stock awards, the computation is easy. The total number given is multiplied by the average stock price. For the stock purchase and ownership plans, we take the percentage subsidy by the firm and multiply this by the number of shares bought by the respective executives. In the case of the convertible debentures granted, again we are plagued by the non-existence of market data. Here the total value granted is the product of the number of debentures granted, the conversion ratio and the average stock price.

Based on the above data, the mean proportions of the three pay categories relative to the total compensation are calculated for the top five executive officers in each of the company. The average stock holdings of the top management as a fraction of the total outstanding shares are also obtained in a similar manner.

Analysis

Multiple regression is used for the analysis with the relevant standardized IS budget deviation as the dependent variable. We also use the natural logarithms of this budget deviation for a separate set of regressions as an indication of robustness of the results.

For the independent variables, we have to operationalize three constructs, namely (1) top management stock ownership, (2) long term emphasis, and (3) short term emphasis. The first and third are straightforward, as discussed earlier. The long term emphasis construct involves deferred and stock value related compensation. If we take the proportion of the sum of these two pay categories as one of the independent variable, there will be perfect collinearity. We, thus, use the interaction of deferred and stock value related pay proportions as a proxy for long

term emphasis. To control for the possible influences of firm size (DeLone, 1981), we incorporate the market value of the firm into all our regressions. This independent variable is obtained by multiplying the total number of outstanding common shares with the average stock price.

We thus initially run two sets of regression for each of the dependent variables (y) to test our three hypotheses. These are specified as follows:

(A) $y = f$ (basic variables, control variable)

(B) $y = f$ (basic variables, interaction variables, control variable)

Finally, we also evaluate *ex post* the possible effects of curvilinearity in the independent variables using the following regression:

(C) $y = f$ (basic variables, squared variables, control variable)

RESULTS

Descriptive Statistics

Table 1 summarizes the means and standard deviations for the IS budget as percentage of revenue based on the top ten IT-effective firms in each of the 13 industries. The estimated grand average for all industries is 2.97 percent with a range from 1 percent to 5 percent. This is approximately similar to the value of 2 percent obtained by PIMS Program (1984) and Strassman (1985). As expected, services oriented industries tend to set higher IS budget than product oriented industries.

Further, we performed an analysis of variance with one main effect to examine the relative proportion of inter-industry versus intra-industry differences. As shown in Table 1, inter-industry variance is 8.3 times intra-industry variance, which indicates strong structural dissimilarities in IT intensiveness across industries. This lends further credence to our approach calling for industry standardization of raw IS budget percentages.

More importantly, the low relative intra-industry variance supports the notion of isomorphism (Hannan and Freeman, 1977; DiMaggio and Powell, 1983), with firms trying to invest as close to the industry-referent level as possible.

Table 2 shows the summary statistics based on our sample of 72 firms for the important variables used in the study. It is noted that current pay constitutes 64 per cent of the executive compensation amount. This compares well to the value of 56 percent in the annual survey of top executives' compensation in 1988, conducted by *Business Week* and *Standard and Poor* (*Business Week*, May 1, 1989) and to the values of 80 and 52 percent for two sampling periods obtained in the classic study of Lewellen (1968). This provides further indication that our sample is not unduly biased in terms of the design of compensation system, thus enhancing the potential generalizability of the results. In addition, our results indicate that the average proportion of deferred and stock value related pay are 22 and 15 percent respectively. The average total compensation for all the executives in the study is \$1.36 million.⁹

The average stock holdings for an individual executive is about 0.5% of the outstanding shares, ranging from a negligible amount to almost 10%. This indicates that no particular individual executive can exert complete voting influence on the company and that other shareholders as a collectivity are an important factor in managerial decision making.

⁹This is compared to \$2.03 million obtained by the *Business Week- Standard and Poor* survey. The difference is due to the fact that we use the top five executives in a firm while that survey involves only the CEOs. In addition, the method of computing items such as stock options is not the same. That survey uses realized benefits whereas our study takes the accrued benefits.

The Pearson correlation coefficients with the corresponding two-tailed p-values are shown in Table 3.

Construct Validity of Industry-Referent IT Investment Level

Before we estimate the regression equations specified earlier, it is important to verify our basic premise that a greater deviation of IT investment from the industry-referent level will give rise to inferior firm performance. For this purpose, we regress the profits of a firm divided by its revenue with the standardized IS budget deviation from the industry-referent level. Here, we use the following functional form:

$$\text{Profit Margin} = \alpha + \beta * \text{Budget Deviation} + \epsilon$$

where ϵ represents some random error.

The sample used is the set of 130 firms that have been utilized to compute the industry-referent IT investment level. From the regression analysis, we obtain an estimated α value of 5.36 with a standard error of 1.04, and an estimated β value of -0.70 with a standard error of 0.37. It is noted that the coefficient for budget deviation has the expected direction of change. Indeed it is statistically significant at the 0.05 level (one-tailed). The results here suggest that firms within an industry tend to do better when the IT investment level is close to the industry-referent level. This finding serves as a foundation for framing our agent-theoretic hypotheses in terms of industry-referent level.

Results of Hypothesis Testing

We use the functional forms (A), (B), and (C) specified earlier for our regression analysis. In Table 4, we present our results with the standardized IS budget deviation as the dependent variable. In Table 5, we show the results when the natural logarithm of the IS budget deviation is

being used as the dependent variable. This serves to assess the robustness of the first set of regressions.

Test of Hypothesis 1. The coefficients pertaining to the proportion of outstanding shares are highly significant and have the correct expected negative signs. All have one-tailed significance levels better than 0.05, and in three cases better than 0.01 (regressions 4B, 4C and 5C). The results provide strong support for Hypothesis 1. The statistical analysis is thus consistent with the agent theoretic tenet that if the agent's welfare is dependent on the outcome of the delegated decision, the actual choice will move toward that effective level for the principal. In other words, by pegging the payoff of the top executives to the stock price by virtue of share ownership, the management will deviate less from the industry-referent level in terms of IT investments.

Test of Hypothesis 2. We have strong support from two regressions (4B and 5B). The coefficients of the interaction of deferred and stock value related pay are in the right expected direction of change with respect to IS budget deviation, and are statistically significant at p-levels better than 0.05. As in Hypothesis 1, this finding is in line with the traditional principal-agent argument advanced in this paper.

Test of Hypothesis 3. The regression results for this hypothesis seem inconclusive or even puzzling. The coefficients pertaining to the proportion of current pay do not have the expected direction of change in some of the cases. It appears that the influence of short term emphasis tends to mitigate the IS budget deviation from the industry-referent level.

We offer some tentative explanations for the results. Firstly, at a *methodological* level, the reverse of coefficient signs could be due to the

inherent weakness of the data, since the proxy statements do not delineate the part of the short term bonus that is dependent on firm performance. Secondly, at a conceptual level, current pay seems to be an important motivational factor in promoting managerial effectiveness. More importantly, by virtue of its public availability, current pay may possess a greatest effect as a symbolic reward (Lawler, 1966). In addition, top managerial task is peculiar in its ambiguity between effort and outcome (Mintzberg, 1973; March, 1984). The setting of an observable IS budget in line with the industry-referent level may well be a signal or symbol of managerial effort or goal alignment with shareholder wealth maximization.

Other Results. These are derived from regressions 4C and 5C. It appears that there is a possibility of positive curvilinearity in the deferred and stock value related pay proportions. From the perspective of the dependent variable, this may partly be due to an effect related to the famous Grosch's Law (Grosch, 1953, 1975; Knight, 1966; Cale et al, 1979). According to this conception, the power of IS increases with the square of their costs. IS budget need then not be linear in the agency determinants as economy of scale can impose a mitigating effect as investment level increases. From the perspective of the independent variable, the curvilinearity may indicate a threshold level in the emphasis on long term pay beyond which risk loving attitudes of the top executive override the perquisite effect. In fact, this explanation is in line with the prospect theory of risk adoption (Kahneman and Tversky, 1979). In addition, we also note that firm size does not seem to have any significant impact on the deviation of the IT investment from the industry-referent level. A possible reason may be that our sample is derived from leading companies listed in

Computerworld Premier 100, which tends to include only larger firms.

DISCUSSION

Research on the determinants and the impact of IT investments is still in its infancy. The traditional view of IT budget along a stage-of-growth model has been rejected and the field is searching for an alternative paradigm for articulating the level of IT investment in a business. It is possible to attribute several determinants such as: the minimal level dictated by the industry context (Weill and Olson, 1989), the specific firm strategy that exploits IT differently from the competitors (McFarlan, 1984) or the incentives and compensation of top managers who exercise their choices in allocating a pool of scarce resources among competing avenues. The industry as a source of variation in IT investments has long been recognized and empirically established in trade periodicals. The link between firm strategy and IT investment is more important for theory building, but has not received much research attention, possibly due to the difficulty in collecting firm-level investment data that can systematically be related to firm strategy and business performance.

Recognizing inter-industry variation, this study modeled the variation in a firm's level of IT investment from an agent-theoretic framework. We found strong support for two of three propositions, thus providing a preliminary justification for the consideration of this framework in IT research. The top management can be induced to pursue activities aligned with the shareholders' best interest if the compensation system is designed to stress long run survival and profitability of the firm, and if the managerial welfare is made contingent on the market value of the firm. The robustness of our results was established through different transformations

of the dependent variable.

Before closing, we enumerate a set of limitations with a view to identifying issues for future research in this stream. At the conceptual level:

1. Agent-Theoretic Model -- Equilibrium Issues

The development of our hypotheses has been rooted in the notion of partial equilibrium. In a general equilibrium, a greater level of managerial stock ownership does not necessarily mean lower agency costs. It may be simply due to the fact that incentive alignment by stock ownership is cheaper than direct monitoring.

2. Dependent Variable -- Aggregation versus Disaggregation.

A fruitful approach would be to decompose the investment into those that are *infrastructure-specific* (i.e. required for maintenance of ongoing activities such as payroll, accounting, inventory, etc.) from those that are *strategy-specific* investments aimed at developing capabilities for the firm to compete in the marketplace (e.g. differentiated customer service, electronic linkages to suppliers, etc.). Our expectation is that the agent-theoretic arguments would be much stronger when the dependent variable is closely related to strategy-specific investments. The finer decomposition of IT investment thus constitutes an useful area of future inquiry.

3. Independent Variables -- Fuller Specification

Firstly, this study has operationalized the agency cost construct via the top management compensation design and stock ownership. There are, in fact, other available agency variables such as a monitoring mechanism like institutional stock ownership (Oviatt, 1988), or a mitigating scheme like golden parachutes for the top management (Singh and Harianto, 1989).

Secondly, this research has taken the prime source of executive motivation to be those pertaining to directly observable income sources such as compensation and stock ownership. In reality, there is a whole spectrum of organization behavioral factors such as power, prestige, job flexibility and satisfaction, personality traits and so on that will influence executive behavior.

Finally but most importantly, it will be useful to specify a broader set of environmental, strategic and organizational factors in determining the IT investment. Here, the decision to invest in IT may be fundamentally dependent on technological opportunities, product market competitiveness, strategic interaction, market evolution, organization adaptiveness and learning, locus of IT decision, and so on.

In this preliminary study, we have considered a set of agency constructs as determinants of IT investment level, while controlling for firm size. Although the significances of the individual variables may be large, a greater degree of overall model explanatory power should be possible with the inclusion of other omitted constructs. In addition, it will be useful to examine whether the relative explanatory power of the agency variables will hold up in an expanded model of IT investments.

At the *methodological level*:

1. Sample Selection

The sample bias problem may be present as we have defined our scope only to leading firms in terms of their IT capability and sophistication. It will definitely be worthwhile to examine the generality of the results with a sample of publicly-held firms taken from the entire economy.

2. Measurement Errors

There are at least three possible sources of errors for compensation variables. Firstly, it will be useful to delineate the portion of long run performance dependent pay from the lump sum current pay. This can be accomplished with more superior information sources such as primary data, than those reported in the proxy statements. Secondly, we can consider the effects of personal taxation on the executive compensation level. This may be difficult in view of heterogeneous tax practices of different states and diverse executive income sources other than through the firm. Thirdly, we have excluded fringe or perquisite benefits offered by the firm to the executive. These may include entities such as corporate cars or even jets, expenditure accounts, club memberships, medical and dental benefits, housing, highly subsidized personal loans and so on. For completeness, these should be added to the total pay of the executive. Again the data collection may be extremely challenging. Complete data may be unavailable and it is difficult to monetize and categorize many of the perquisites.

As for our dependent variable, the reported budget level may be subjected to errors originating from corporate reportings in areas such as differential accounting conventions, subjective judgements, diverse definitions of IS budget in firms etc.

CONCLUSION

The study examined agent-theoretic determinants of IT investment decision by firms. In particular, we analyze how the deviation of IS budget from the industry-referent level is influenced by both short and long term emphases of the executive compensation package as well as by top management stock ownership. Strong evidences suggest that long term emphasis and

executive stock ownership tend to mitigate the IS budget deviation from the industry-referent level. In view of the limitations inherent in this study, several directions of future research are highlighted. In this respect, it is hoped that our present effort will inspire further integrative inquiry into this exciting area of IT research.

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APPENDIX A: LIST OF COMPANIES

<u>Company Name</u>	<u>Industry</u>
Abbott Laboratories	Pharmaceutical & Food
American Express Co	Financial Services & Insurance
American President Cos Ltd	Transportation
Amoco Corp	Petroleum
AMR Corp	Transportation
Atlantic Richfield Co	Petroleum
AT&T	Utilities
Banc One Corp	Banking
Bankers Trust	Banking
Becton Dickinson & Co	Equipment & Materials Manufacturing
Bell Atlantic Corp	Utilities
Berkshire Hathaway, Inc	Consumer Products
Black & Decker Corp	Industrial & Automotive Products
Boise Cascade Corp	Equipment & Materials Manufacturing
Citicorp	Banking
Contel Corp	Utilities
Dover Corp	Industrial & Automotive Products
Dow Chemical Co	Chemicals
Duke Power Co	Utilities
Dun & Bradstreet Corp	Diversified Services
Farmers Group, Inc	Financial Services & Insurance
Federal Express Corp	Transportation
First Union Corp	Banking
Fleet/Norstar Financial	Financial Services & Insurance
Freeport-McMoran, Inc	Chemicals
Gencorp Inc	Aerospace
General Dynamics Corp	Aerospace
General Signal Corp	Equipment & Materials Manufacturing
Gillette Co	Consumer Products
Goodyear Tire & Rubber Co	Equipment & Materials Manufacturing
Great Northern Nekoosa	Equipment & Materials Manufacturing
Great Western Financial Corp	Banking
Grumman Corp	Aerospace
GTE Corp	Utilities
Ingersoll-Rand Co	Industrial & Automotive Products
ITT	Utilities
Johnson & Johnson	Pharmaceuticals & Food
J.C. Penny Co.	Retailing
J.P. Morgan & Co	Banking
Kemper Corp	Financial Services & Insurance
Keycorp	Banking
Lafarge Corp	Equipment & Materials Manufacturing
Lockheed Corp	Aerospace

APPENDIX A: Continued

Mack Trucks, Inc	Industrial & Automotive Products
Martin Marietta Corp	Aerospace
Masco Corp	Consumer Products
McDonnell Douglas Corp	Aerospace
McGraw-Hill, Inc	Consumer Products
MCI Communications Corp	Utilities
Mellon Bank Corp	Banking
Merck & Co	Pharmaceuticals & Food
Monsanto Co	Chemicals
National City Corp	Banking
NCNB Corp	Banking
Nortek, Inc	Equipment & Materials Manufacturing
Northeast Utilities	Utilities
Norwest Corp	Banking
Owens-Corning	Equipment & Materials Manufacturing
Paine Webber Group, Inc	Financial Services & Insurance
Polaroid Corp	Consumer Products
Sara Lee Corp	Pharmaceutical & Foods
Schering-Plough Corp	Pharmaceuticals & Food
Security Pacific Corp	Banking
Shawmut National Corp	Banking
Signet Banking Corp	Banking
Southwestern Bell	Utilities
Sovran Financial Corp	Banking
Temple-Inland, Inc	Equipment & Materials Manufacturing
Textron, Inc	Aerospace
The Boeing Co	Aerospace
The Mead Corp	Equipment & Materials Manufacturing
Timken Co	Industrial & Automotive Products
Union Texas Petroleum Corp	Petroleum
Unocal Corp	Petroleum
US Bancorp	Banking
US West	Utilities
Valley National Corp	Banking
Warner Communications, Inc	Consumer Products

TABLE 1: INDUSTRY MEANS AND STANDARD DEVIATIONS
FOR IS BUDGET AS PERCENTAGE OF REVENUE

INDUSTRY	MEAN	STANDARD DEVIATION
Aerospace	4.82	1.56
Banking	4.95	0.74
Chemicals	1.81	0.54
Consumer Products	3.10	2.64
Diversified Services	1.95	1.12
Equipment & Materials Manufacturing	2.04	1.25
Financial Services & Insurance	4.13	1.69
Industrial & Automotive Products	2.35	1.11
Petroleum	1.09	0.41
Pharmaceuticals & Foods	2.02	0.83
Retailing	1.42	1.10
Transportation	5.14	3.20
Utilities	3.73	1.54
OVERALL MEAN	2.97	
MODEL MEAN SQUARE ERRORS (INTERINDUSTRY VARIANCE)	20.40	$F = 8.33$ $R^2 = 0.46$
RESIDUAL MEAN SQUARE ERRORS (INTRAINDUSTRY VARIANCE)	2.45	

TABLE 2: SUMMARY STATISTICS

	MEAN	STANDARD DEVIATION
Absolute IS Budget Deviation from Industry Characteristic Level	0.745	0.649
Natural Logarithms of Absolute IS Budget Deviation Industry Characteristic Level	-0.747	1.113
Proportion of Current Compensation	0.636	0.164
Proportion of Deferred Compensation	0.216	0.149
Proportion of Stock Value Related Compensation	0.148	0.178
Proportion of Outstanding Shares Owned	0.00546	0.0159
Interaction of Current and Deferred Compensation	0.129	0.0754
Interaction of Current and Stock Value Related Compensation	0.0762	0.0789
Interaction of Deferred and Stock Value Related Compensation	0.0185	0.0218
Square of Current Compensation Proportion	0.431	0.207
Square of Deferred Compensation Proportion	0.0684	0.0819
Square of Stock Value Related Compensation Proportion	0.0532	0.0992
Market Value of Firm	4.34×10^9	5.02×10^9

TABLE 3: CORRELATION COEFFICIENTS WITH TWO-TAILED P-VALUES IN PARENTHESES

	Budget Deviation	Log.Budget Deviation	Short Term Emphasis	Long Term Emphasis	Stock Holdings	Market Value
Budget Deviation	1.000					
Log.Budget Deviation	0.830 (0.001)	1.000				
Short Term Emphasis	-0.112 (0.349)	-0.031 (0.798)	1.000			
Long Term Emphasis	-0.005 (0.970)	-0.117 (0.327)	-0.629 (0.001)	1.000		
Stock Holdings	-0.155 (0.193)	-0.168 (0.157)	-0.142 (0.233)	-0.095 (0.425)	1.000	
Market Value	0.008 (0.949)	0.070 (0.558)	-0.126 (0.291)	0.047 (0.697)	-0.178 (0.134)	1.000

TABLE 4: REGRESSION RESULTS USING THE STANDARDIZED IS BUDGET DEVIATION AS THE DEPENDENT VARIABLE

	<u>Regression 4A</u>	<u>Regression 4B</u>	<u>Regression 4C</u>
Intercept	1.640 (0.430) [***]	4.091 (1.492) [***]	-0.641 (2.209)
Proportion of Current Compensation	-0.917 (0.528) [**]	-2.861 (1.402) [**]	1.207 (5.393)
Proportion of Deferred Compensation	-0.985 (0.601) [*]	-0.467 (2.326)	
Proportion of Outstanding Shares Owned	-22.726 (12.154) [**]	-35.821 (13.381) [***]	-37.469 (13.153) [***]
Interaction of Current and Deferred Compensation		-5.828 (3.918)	
Interaction of Current and Stock Value Related Compensation		-4.483 (3.390)	
Interaction of Deferred and Stock Value Related Compensation		-10.218 (5.156) [**]	
Square of Current Compensation Proportion			0.605 (3.530)
Square of Deferred Compensation Proportion			3.366 (2.325) [*]
Square of Stock Value Related Compensation Proportion			5.330 (2.535) [**]
Market Value of Firm	1.524×10^{-13} (1.612×10^{-11})	-1.055×10^{-12} (1.584×10^{-11})	-3.204×10^{-12} (1.552×10^{-11})
R ²	0.08	0.17	0.16

NOTE: [***], [**] and [*] denote 1-tailed statistical significance at 0.01, 0.05 and 0.10 levels respectively.

TABLE 5: REGRESSION RESULTS USING THE NATURAL LOGARITHMS OF THE
STANDARDIZED IS BUDGET DEVIATION AS THE DEPENDENT VARIABLE

	<u>Regression 5A</u>	<u>Regression 5B</u>	<u>Regression 5C</u>
Intercept	0.153 (0.749)	2.358 (2.600)	-7.442 (3.876) [**]
Proportion of Current Compensation	-0.835 (0.920)	-2.754 (2.443)	13.350 (9.441) [*]
Proportion of Deferred Compensation	-1.421 (1.048)	0.277 (4.054)	
Proportion of Outstanding Shares Owned	-35.499 (21.184) [**]	-53.619 (23.318) [**]	-57.755 (23.026) [***]
Interaction of Current and Deferred Compensation		-6.031 (6.828)	
Interaction of Current and Stock Value Related Compensation		-1.205 (5.908)	
Interaction of Deferred and Stock Value Related Compensation		-22.944 (8.985) [***]	
Square of Current Compensation Proportion			-6.452 (6.179)
Square of Deferred Compensation Proportion			7.822 (4.070) [**]
Square of Stock Value Related Compensation Proportion			11.302 (4.438) [***]
Market Value of Firm	1.591×10^{-11} (2.809×10^{-11})	1.561×10^{-11} (2.760×10^{-11})	1.022×10^{-11} (2.715×10^{-11})
R ²	0.06	0.15	0.13

NOTE: [***], [**] and [*] denote 1-tailed statistical significance at 0.01,
0.05 and 0.10 levels respectively.

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